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ABSTRACT

By using the paired comparison methodology, it was possible to establish evaluative priorities, providing criterion weights which reflected the thoughts and feelings of an advisory committee consisting of experts in the task selection process. For the U.S. Army Infantry School, the weights can be used to stress higher weighted criterion results in the task selection process. By extending the size and diversity of the advisory committee, the use of paired comparison methodology can provide an effective, reliable procedure for (1) constructing evaluative criterion weights for the task selection process and in other areas which have multiple criteria used for evaluative purposes and (2) incorporating into an evaluative design the valuable contributions of various experts and interest groups. (Author/BW)

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CONSTRUCTION OF CRITERION WEIGHTS FOR THE SELECTION OF TASKS FOR TRAINING IN THE UNITED STATES ARMY INFANTRY SCHOOL

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Under the Instructional Systems Development concept being implemented at the United States Army Infantry School at Ft. Benning, Georgia, and at other service schools across the nation, the first prerequisite for the design and development of instruction is that a "Job Analysis" be conducted. From that job analysis and by the use of certain prespecified criteria, job "tasks" are selected as appropriate for instruction in the formal branch school setting. Tasks not selected for training in the formal school setting are then considered for instruction by an alternative mode or is determined not to be worthy of training in any setting. In order to make the task selection decision (for training in formal school setting) eight criteria are listed in Phase I of ISD (DA Pamphlet 350-30, Phase I) as to be used in making the decision. These criteria, collectively, are designed to determine the "criticality" of the task and, thusly, the appropriateness of the formal school to undertake the training of the student on this task. There exists no formal measure of the weight which should be given to each criterion. Because of the lack of existance of relative weights which should be given to each criterion.much discretion is left in the hands of the many individuals involved in the task selection process and, therefore, there is little faith in the continuity and reliability of the decisions. The intent of the present study was to construct scale weights for the eight decision-making criteria so as to assist the decision-makers in arriving at more accurate, reliable, and consistant decisions in the task selection process. By doing so it is hoped that the "critical" tasks can be more easily and accurately identified with the resultant benefits of savings in

development and training time and a training program more accurately reflective of the competencies required on the job.

Methodology

In Phase I (Analysis) of the ISD procedures (DA Pamphlet 350-30), eight criteria are suggested as being appropriate for use in making the task selection decision. After research in the area of task selection criteria and due to the lack of recommendations for additions to the list, it was decided to use the list intact with no additions or deletions from the criteria list as presented in the ISD procedures. The ISD model includes, and this study used, these eight criteria:

1. PERCENT PERFORMING - The percentage of soldiers surveyed who actually perform the task.
2. PERCENT TIME SPENT PERFORMING - Percent of total work time spent performing task.
3. PROBABLE CONSEQUENCE OF INADEQUATE PERFORMANCE - The degree to which inadequate or improper performance of the task would adversely effect mission accomplishment, equipment, or personnel.
4. TASK DELAY TOLERANCE - The amount of time that can be tolerated between the initiating cue and the actual performance.
5. FREQUENCY OF PERFORMANCE - The likelihood that a task will be performed frequently enough to require training.
6. TASK LEARNING DIFFICULTY - The amount of time required to learn the task to an acceptable level of performance.
7. PROBABILITY OF DEFICIENT PERFORMANCE - the likelihood that job incumbents will fail to perform a task adequately.
8. IMMEDIACY OF PERFORMANCE (Listed as "Time Between Job Entry and Task Performance on Instrument) - The time lapse between an individual's assignment to a job and the time when he is expected to perform the task.

This study sought to determine a criteria weighting scheme which reflected the perceived importance placed on each of the eight criteria by an advisory committee. In this case the advisory committee consisted of

some twenty-nine individuals working at the United States Army Infantry School at Ft. Benning as of Nov. 1978. The committee included individuals from the Staff and Faculty Training Department, Directorate of Training; the Directorate of Training Development; and the Directorate of Evaluation. All respondents were familiar with Phase I (Analysis) of the ISD procedures having completed or designed the in-house ISD training course. The respondents consisted of civilian educational specialists and their military job counterparts. Criterion weights were determined by paired comparison methodology.

Paired Comparison Procedures

Each member of the group selected for the advisory committee was given a questionnaire containing the 28 paired comparison statements presented in Table 1, as well as the eight criteria and their definitions (presented previously in this paper) as an accompanying sheet. Respondents were advised of the general purpose of the instrument and asked to comment on the importance of each criterion in the evaluation of tasks for training by responding to the following questionnaire directions:

> Please consider each pair of criteria below and select by circling the corresponding letter (a. or b.) of the criterion which you believe is the more important of the pair in determining which tasks to select for training in the formal school setting.

Of twenty-nine questionnaires distributed, all were returned in a usable condition. Individual judgments were then evaluated for inconsistent responses by calculating zeta, the coefficient of consistancy. This index represents the complement of the ratio of the number of circular triads (inconsistencies) per individual to the maximum number of circular triads that can occur. An example of a circular triad is a situation where an individual prefers statement A to B, B to C, yet inconsistently follows with

Table 1

Sample Questionnaire with Criteria Paired Comparisons

Under Phase One of ISD certain criteria are listed for determining what tasks are to be trained in the formal school setting and what tasks should be left for training on the job in the unit. We would like your professional opinion on the relative importance of each of these criteria towards making the task by circling the corresponding letter (a. or b.) of the criterion which you believe is the more important of the pair in determining which tasks to select for training in the formal school setting.

1. a. Task Learning Difficulty or b. Frequency of Performance
2. a. Probable Consequences of Inadequate Performance or b. Percent Performing
3. a. Percent of Time Spent Performing or b. Task Delay Tolerance
4. a. Time Between Job Entry and Task Performance or b. Task Learning Difficulty
5. a. Frequency of Performance or b. Probability of Deficient Performance
6. a. Percent Performing or b. Percent of Time Spent Performing
7. a. Task Delay Tolerance or b. Time Between Job Entry and Task Performance
8. a. Task Learning Difficulty or b. Probability of Deficient Performance
9. a. Probable Consequences of Inadequate Performance or b. Frequency of Performance
10. a. Time Between Job Entry and Task Performance or b. Percent Performing
11. a. Task Delay Tolerance or b. Task Learning Difficulty
12. a. Probability of Deficient Performance or b. Probable Consequences of Inadequate Performance
13. a. Frequency of Performance or b. Percent of Time Spent Performing
14. a. Percent Performing or b. Task Delay Tolerance
15. a. Task Learning Difficulty or b. Probable Consequences of Inadequate Performance
16. a. Percent of Time Spent Performing or b. Probability of Deficient Performance
17. a. Time Between Job Entry and Task Performance or b. Frequency of Performance
18. a. Percent Performing or b. Task Learning Difficulty
19. a. Probable Consequences of Inadequate Performance or b. Percent of Time Spent Performing
20. a. Probability of Deficient Performance or b. Time Between Job Entry and Task Performance
21. a. Frequency of Performance of b. Task Delay Tolerance
22. a. Task Learning Difficulty or b. Percent of Time Spent Performing
23. a. Time Between Job Entry and Task Performance or b. Probable Consequences of Inadequate Performance
24. a. Task Delay Tolerance or b. Probability of Deficient Performance
25. a. Percent Performing or b. Frequency of Performance
26. a. Percent of Time Spent Performing or b. Time Between Job Entry and Task Performance
27. a. Probable Consequences of Inadequate Performance or b. Task Delay Tolerance
28. a. Probability of Deficient Performance or b. Percent Performing

favoring C to A. Zeta is defined as:

$$\underline{z} = 1 - \frac{24d}{n^3-n}$$

where $\underline{z}$ = coefficient of consistency;

n = number of stimuli to be judged;

d = observed number of circular triads.

A zeta of .71 or greater ($p < .05$) was required to retain an individual's response to the paired comparison scale. Three returns were subsequently rejected due to the statistical significance of their number of inconsistent responses. After this final elimination, criterion weights were derived from the remaining 26 questionnaires utilizing the paired comparison procedures.

Responses to the paired comparison statements (criterion measures) were arranged in an F matrix which contains the frequencies with which each column criterion measure was judged more important than the row criterion measure. The F matrix is presented in Table 2.

Table 2

The F Matrix for 8 Statements Judged by 26 Individuals

Statement	1	2	3	4	5	6	7	8
1		7	22	8	7	10	4	15
2	19		24	16	14	12	8	23
3	4	2		6	3	2	3	5
4	18	10	20		11	16	9	21
5	19	12	23	15		15	10	20
6	16	14	24	10	11		8	21
7	22	18	23	17	16	18		22
8	11	3	21	5	6	5	4	

To illustrate, inspection of the first column entries shows that 19 individuals believed that criterion measure one, "Task Learning Difficulty," was more important in the evaluation of tasks for training in the formal school setting than was criterion two, "Frequency of Performance." The total number of comparative judgments for each pair of statements was 26, the number of individuals making judgments. By dividing each cell entry presented in Table 2 by the total number of respondents (N), the proportional (P_{ij}) entries shown in Table 3 were obtained.

Table 3

The P Matrix Corresponding to the F Matrix of Table 2

Statement	1	2	3	4	5	6	7	8
1		.27	.85	.31	.27	.38	.15	.58
2	.73		.92	.62	.54	.46	.31	.88
3	.15	.08		.23	.12	.08	.12	.19
4	.69	.38	.77		.42	.62	.35	.81
5	.73	.46	.88	.58		.58	.38	.77
6	.62	.54	.92	.38	.42		.31	.81
7	.85	.69	.88	.65	.62	.69		.85
8	.42	.12	.81	.19	.23	.19	.15	

Using a table of normal deviates corresponding to proportions of a dichotomized unit normal distribution, it was possible to find corresponding Z_{ij} values for the P_{ij} entries of Table 3. For example, returning to the comparison of criterion measures one and two, it was observed that 19 individuals (P of .73) indicated a preference for criterion measure one over two. By looking up the $P_{2,1}$ value of .73 on the table of normal deviates one can obtain a corresponding $Z_{2,1}$ value of .613. This substitution procedure provided the Z_{ij} values presented in Table 4.

Table 4

The Z Matrix Corresponding to the P Matrix of Table 3

Statement	1	2	3	4	5	6	7	8
1		-.613	1.04	-.496	-.613	-.305	-1.04	.20
2	.613		1.405	.305	.100	-.100	-.496	1.175
3	-1.04	-1.405		-.739	-1.175	-1.405	-1.175	-.878
4	.496	-.305	-.739		-.202	.305	-.385	.878
5	.613	-.100	1.175	.202		.202	-.305	.739
6	.305	.100	1.405	-.305	-.202		-.496	.878
7	1.04	.496	1.175	.385	.305	.496		1.036
8	-.20	-1.175	.878	-.878	-.739	-.878	-1.036	
				Summary Data				
(1) Sums	1.827	-3.002	7.817	-1.526	-2.526	-1.685	-4.933	4.028
(2) Means	.228	-.375	.977	-.191	-.316	-.211	-.616	.504
(3) Means	.844	.241	1.593	.425	.300	.405	.000	1.120
+.616 (scale values)								

Column entries of Table 4 were then summed. The mean Z values or the scale value of each statement in terms of its deviation from the mean of all scale values were computed by dividing the column totals by the number of criteria (8). These mean Z values (scale values) are the resultant criterion weights presented in row (2) at the bottom of Table 4. As a check upon one's calculations, the sum of the scale values in deviation form may be obtained and this sum should be equal to zero. Negative weights are interpreted as being judged less favorable than the average of the scale values of all statements. Positive values are judged to be more favorable than the average. One can make the deviation scale values all

positive by adding a constant which is the absolute scale value of the statement with the largest negative deviation. For the purposes of the study, a value of .616 was added to all scale values, thus producing the final criterion weights presented in row (3) at the bottom of Table 4.

The finalized criterion weights or scale values are presented along with their respective criterion measure in Table 5.

Table 5

Paired Comparison Criterion Weights

Criteria	Weight
1. Probable Consequences of Inadequate Performance	1.593
2. Probability of Deficient Performance	1.120
3. Task Learning Difficulty	.844
4. Percent Performing	.425
5. Task Delay Tolerance	.405
6. Percent of Time Spent Performing	.300
7. Frequency of Performance	.241
8. Immediacy of Performance	.000

Results and Discussion

An analysis of the criterion weights suggests that the advisory committee split the eight criterion statements into two groups emphasizing one group of three as being more important criteria in helping to make the task selection decision than the other five. The committee placed great emphasis on the importance of the "Probable Consequences of Inadequate Performance" in making the task selection decision. Also, in the first

group (although somewhat distant) was the "Probability of Deficient Performance," and the "Task Learning Difficulty." It was apparent that the criteria of inadequate or deficient performance of a task and the difficulty in learning the task should predominate the task selection decision.

In the ISD model for the task selection decision, the weights can be used to stress the higher criterion results in making the final task evaluation decisions. Through the use of certain survey instruments and some existing data on each of the eight criteria, each task (or group of tasks for those tasks closely related) can be assigned a single number indicative of its importance or "criticality" based upon he importance of each criterion. For example, for each of the eight criteria data can be collected which would measure that criteria (the number of people performing a task or tasks, the percent of time spent performing the task(s), a rating of the consequencies of inadequate performance, the frequency of performing a task, etc.). For each criteria, the data collected would be placed on a scale having an equal number of divisions. The rating of the task(s) on the criteria would then be multiplied by the corresponding criterion weight. By doing this for each criteria (or the most important criteria or, if some data is unavailable, on those criteria for which data is available) and then summing the products, a single aggregate criterion score for the task(s) can be determined. This aggregate score can then be easily compared with other aggregate scores to make the task selection decision. For example, each task can be rated as HIGH, MEDIUM, or LOW on each criteria (i.e., high percentage of people performing the task, high frequency of performance, high (severe) consequencies of inadequate performance, medium percentage of time spent performing, low immediacy of performance, etc.). Then points can be

assigned to the HIGH, MEDIUM, and LOW categories (normally 3, 2, and 1, respectively). The points that a task earns on each criterion can then be multiplied by the criterion weight and summed to obtain the aggregate score. An example is given below:

Evaluated Task Title: Fire the .45 Caliber Pistol

	HIGH (3 pts)	MEDIUM (2 pts)	LOW (1 pt)
Criterion 1	3 X 2.59	____ X 2.59	____ X 2.59
Criterion 2	____ X 2.12	2 X 2.12	____ X 2.12
Criterion 3	____ X 1.84	____ X 1.84	1 X 1.84
Criterion 4	____ X 1.42	2 X 1.42	____ X 1.42
Criterion 5	____ X 1.40	2 X 1.40	____ X 1.40
Criterion 6	3 X 1.30	____ X 1.30	____ X 1.30
Criterion 7	____ X 1.24	____ X 1.24	1 X 1.24
Criterion 8	3 X 1.00	____ X 1.00	____ X 1.00
Total	14.67 +	9.88 +	3.08 = 27.63 Aggregate Criterion Score

Figure 1. Task Evaluation Procedures

The intent of the previous example is to have decision makers review and compare aggregate task criterion scores as indicators of task criticality. It is believed that these comparisons can be made useful in the task selection decision-making process.

Summary

By using the paired comparison methodology, it was possible to establish evaluative priorities, providing criterion weights which reflected the thoughts and feelings of an advisory committee consisting of experts in the task selection process. For the Infantry School, the weights can be used to stress higher weighted criterion results in the task

selection process. By extending the size and diversity of the advisory committee, the use of paired comparison methodology can provide an effective, reliable procedure for (1) constructing evaluative criterion weights for the task selection process and in other areas which have multiple criteria used for evaluative purposes and (2) incorporating into an evaluative design the valuable contributions of various experts and interest groups.